

IN THE CLAIMS

1-315. (Canceled)

316. (Currently Amended) An automated optical inspection device, suitable for inspection of an article, ~~and~~ comprising:

at least one detector providing a polychromatic image output of at least a portion of an article; and

processing circuitry receiving said polychromatic image output and providing edge detection to sub-pixel accuracy operative to distinguish borders among regions of different color, said processing circuitry being operative to distinguish a border between a first color region associated with a first color population and a second color region associated with a second color population by identifying an approximate border location between said first color region and said second color region and determining a location of a border between said first color region and said second color region by using a preferred method for identifying the location of a border between said first color population and said second color population.

317. (Canceled)

318. (Currently Amended) An automated optical inspection device according to claim ~~317~~ 316, ~~and~~ wherein said polychromatic image output comprises a color image represented using a color

image representation method having a plurality of color defining characteristics, and  
each said preferred method is selected from a plurality of available methods, and  
the plurality of available methods includes, for each color defining characteristic within  
the plurality of color defining characteristics, a method comprising performing an edge locating  
method in a component of the color image associated with said color defining characteristic.

319. (Previously Presented) An automated optical inspection device according to claim 318 and  
wherein the edge locating method comprises a sub-pixel contour-element locating method.

320. (Currently Amended) An automated optical inspection device, suitable for inspection of an  
article, ~~and~~ comprising:

at least one detector providing an image output of at least a portion of an article  
having at least three different regions, each of which regions is distinguished at least by an optical  
characteristic detectable by said detector; and

processing circuitry receiving said image output and providing edge detection to  
sub-pixel accuracy operative to distinguish borders of ~~at least two of~~ said at least three different  
regions.

321. (Canceled)

322. (Previously Presented) An automated optical inspection device according to claim 320 and  
wherein said processing circuitry provides mapping based at least partially on said image output  
which identifies materials in each of said different regions having a common border.

323-324. (Canceled)

325. (Currently Amended) An automated optical inspection device suitable for inspection of an article comprising:

at least one detector providing a polychromatic image output of at least a portion of an article; and

processing circuitry receiving said polychromatic image output and providing at least one of the following inspection functionalities:

segmentation of said polychromatic image into a segmented color image comprising a plurality of color regions each having one of a plurality of representative color possibilities;

binarization of the segmented color image into a binary image including regions and borders;

morphological erosion of the regions to provide a skeleton representing the regions; and

assignment of color regions to elements in the skeleton;

said processing circuitry being operative to superimpose the skeleton and the segmented color image, and to assign data representative of regions to elements in the skeleton as a function of the superimposition.

326. (Canceled)

327. (Currently Amended) An automated optical inspection device according to ~~claim 326~~claim 325 and wherein the processing circuitry is operative to assign data representative of regions to elements in the skeleton as a function of the superimposed location of an element of the skeleton in a color region.

328-353. (Canceled)

354. (Currently Amended) An automated optical inspection device, suitable for inspection of an article, comprising:

at least one detector providing a polychromatic image output of at least a portion of an article, said article comprising an electrical circuit formed on a printed circuit board; and

processing circuitry receiving said polychromatic image output and providing a color image representing said article, the color image comprising a map which indicates borders between different regions of an article and identifies materials in each of said different regions having a common border, said different regions including uncoated metal conductors, coated metal conductors, uncoated substrate, and coated substrate.

355. (Previously Presented) An automated optical inspection device according to claim 354 and wherein colors of portions of said map indicate materials at various regions of the article.

356. (Previously Presented) An automated optical inspection device according to claim 354 and wherein said processing circuitry receives said image output and provides border indication to sub-pixel accuracy.

357. (Previously Presented) An automated optical inspection device according to claim 355 and wherein each color comprises a color chosen from among a predetermined possibility of colors.

358-359. (Canceled)

360. (Currently Amended) An automated optical inspection device according to ~~claim 359~~claim 354 and wherein the electrical circuit comprises a ball grid array substrate.

361. (Previously Presented) An automated optical inspection device according to claim 354 and wherein the patterned article comprises a lead frame.

362. (Previously Presented) An automated optical inspection device according to claim 354 and wherein the different materials include different metals.

363. (Canceled)

364. (Previously Presented) An automated optical inspection device according to claim 354 and wherein the patterned article comprises an etched metal substrate.

365. (Previously Presented) An automated optical inspection device according to claim 354 and wherein the patterned article comprises an engraved metal substrate.

366-372. (Canceled)

373. (Currently Amended) An automated optical inspection device, suitable for inspection of a patterned article, comprising:

at least one detector providing an image output of at least a portion of a patterned article comprising a plurality of materials having detectable borders between the plurality of materials, said plurality of materials comprising at least three materials; and

processing circuitry receiving said image output and providing an inspection functionality comprising pattern analysis of image data relating to the borders to provide an indication of the presence of nicks and protrusions along said borders.

374. (Previously Presented) An automated optical inspection device according to claim 373 and wherein said patterned article comprises an electrical circuit.

375. (Previously Presented) An automated optical inspection device according to claim 374 and wherein said patterned article comprises a printed circuit board.

376. (Previously Presented) An automated optical inspection device according to claim 375 and wherein said printed circuit board comprises a ball grid array substrate.

377. (Previously Presented) An automated optical inspection device according to claim 374 and wherein said patterned article comprises a lead frame.

378. (Canceled)

379. (Currently Amended) An automated optical inspection device according to ~~claim 378~~ claim 373 and wherein said materials include materials from the following group: uncoated metal conductors, coated material conductors, uncoated substrate, coated substrate.

380. (Previously Presented) An automated optical inspection device according to claim 374 and wherein said patterned article comprises an etched metal substrate.

381. (Previously Presented) An automated optical inspection device according to claim 374 and wherein the patterned article comprises an engraved metal substrate.

382. (Previously Presented) An automated optical inspection device according to claim 373 and wherein said inspection functionality comprising pattern analysis includes:

- identifying an ordered plurality of points along a border defined by the image data relating to the borders, each of said ordered plurality of points having at least one neighboring point in the ordered plurality of points;

- determining a normal direction to the smooth curve at each of said ordered plurality of points; and

- identifying a point of said ordered plurality of points as being part of an irregularity comprising one of a nick and a protrusion based, at least in part, on a local normal difference comprising a difference between the normal direction to the smooth curve at said point and a normal direction to the smooth curve at said at least one neighboring point of said point.

383-395. (Canceled)

396. (Currently Amended) An automated optical inspection device, suitable for inspection of an electrical circuit, comprising:

at least one detector providing an image output of at least a portion of an electrical circuit comprising multiple materials; and

processing circuitry receiving said image output and providing an output indication of the presence of at least ~~one predetermined material~~ two materials out of a group of at least three predetermined materials.

397. (Previously Presented) An automated optical inspection device according to claim 396 and wherein said electrical circuit comprises a printed circuit board.

398. (Previously Presented) An automated optical inspection device according to claim 397 and wherein said printed circuit board comprises a ball grid array substrate.

399. (Previously Presented) An automated optical inspection device according to claim 398 and wherein said electrical circuit comprises a flat panel display substrate.

400. (Canceled)

401. (Previously Presented) An automated optical inspection device according to claim 396 and



wherein said processing circuitry provides an output indication of the presence of at least three predetermined materials.

402. (Previously Presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of copper.

403. (Previously Presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of gold.

404. (Previously Presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of a solder mask material.

405. (Previously Presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of silver.

406. (Previously Presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of photoresist residue.

407. (Previously Presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of oxidized metal.

408. (Previously Presented) An automated optical inspection device according to claim 396 and wherein said image output represents a portion of the electrical circuit as viewed through a translucent overlay.

409. (Currently Amended) An automated optical inspection device, suitable for inspection of a patterned article, comprising:

at least one detector providing an image output of at least a portion of a patterned article through a translucent overlay at least partially covering the patterned article; and

processing circuitry receiving said image output and providing an output indication which is independent of the translucent overlay, said processing circuitry being operative to provide an indication of parts of the pattern covered by the translucent overlay and parts of the pattern not covered by the translucent overlay.

410. (Previously Presented) An automated inspection device according to claim 409 and wherein the patterned article comprises an electrical circuit.

411. (Previously Presented) An automated inspection device according to claim 410 and wherein the electrical circuit comprises a printed circuit board.

412. (Previously Presented) An automated inspection device according to claim 411 and wherein the printed circuit board comprises a ball grid array substrate.

413-436. (Canceled)

437. (Currently Amended) Apparatus for automatically optically inspecting color images of objects, comprising:

a sensor operative to acquire polychromatic images of an object;

an image processor operative to process the polychromatic images and output a report indicating candidate defects and features chosen from among a predetermined set of features, and to provide an image of a region surrounding each said candidate defect and feature, said image processor including a binary image processor operative to process binary images generated from the polychromatic images, and a color image processor operative to process the polychromatic images.

438. (Canceled)

439. (Previously Presented) Apparatus according to claim 437 and further comprising a morphological image processor operative to generate a skeleton map from a multicolor image derived from the polychromatic image.

440. (New) An automated optical inspection device suitable for inspection of an article and comprising:

at least one detector providing an image output of at least a portion of an article having at least three different regions, each of which regions is distinguished at least by an optical characteristic detectable by said detector; and

processing circuitry receiving said image output and providing edge detection to sub-pixel accuracy operative to distinguish borders of at least two of said at least three different

regions, said processing circuitry providing mapping based at least partially on said image output identifying materials in each of said different regions having a common border.

441. (New) An automated optical inspection device suitable for inspection of an article comprising:

at least one detector providing a polychromatic image output of at least a portion of an article; and

processing circuitry receiving said polychromatic image output and providing at least one of the following inspection functionalities:

segmentation of said polychromatic image into a segmented color image comprising a plurality of color regions each having one of a plurality of representative color possibilities;

binarization of the segmented color image into a binary image including regions and borders;

morphological erosion of the regions to provide a skeleton representing the regions; and

assignment of color regions to elements in the skeleton,  
said processing circuitry being operative to assign data representative of regions to elements in the skeleton as a function of a superimposed location of an element of the skeleton in a color region.

442. (New) An automated optical inspection device suitable for inspection of an article comprising:

at least one detector providing a polychromatic image output of at least a portion of an article; and

processing circuitry receiving said polychromatic image output and providing a color image representing said article, the color image comprising a map which indicates borders between different regions of an article and identifies materials in each of said different regions having a common border, said different materials including different metals.

443. (New) An automated optical inspection device suitable for inspection of a patterned article comprising:

at least one detector providing an image output of at least a portion of a patterned article comprising a plurality of materials having detectable borders between the plurality of materials, said materials include materials from the following group: uncoated metal conductors, coated material conductors, uncoated substrate, coated substrate; and

processing circuitry receiving said image output and providing an inspection functionality comprising pattern analysis of image data relating to the borders to provide an indication of the presence of nicks and protrusions along said borders.

444. (New) An automated optical inspection device suitable for inspection of a patterned article comprising:

at least one detector providing an image output of at least a portion of a patterned article comprising a plurality of materials having detectable borders between the plurality of materials; and

processing circuitry receiving said image output and providing an inspection functionality comprising pattern analysis of image data relating to the borders to provide an indication of the presence of nicks and protrusions along said borders, said inspection functionality comprising pattern analysis including:

identifying an ordered plurality of points along a border defined by the image data relating to the borders, each of said ordered plurality of points having at least one neighboring point in the ordered plurality of points;

determining a normal direction to the smooth curve at each of said ordered plurality of points; and

identifying a point of said ordered plurality of points as being part of an irregularity comprising one of a nick and a protrusion based, at least in part, on a local normal difference comprising a difference between the normal direction to the smooth curve at said point and a normal direction to the smooth curve at said at least one neighboring point of said point.